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Comparison of Proprioception between Kinesiology and Adhesive Ankle Taping: A Randomised Experimental Study

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Abstract

Background: Literature shows conflicting results regarding the effects of Adhesive and Kinesiology taping effect on ankle proprioception.

Objectives: To investigate the effectiveness of Adhesive Taping (AT) and Kinesiology Taping (KT) on the ankle proprioception on a multi axial plane of motion and compare the two methods for any pre-eminence between them.

Design: Randomised experimental study

Method: Twenty healthy University affiliated participants were recruited. The participants were examined with the Biodex Balance Scale (BBS), in three parameters: non-taped, AT and KT taping in a random order. A monopodal, dominant leg stance was utilised during the trials. Repeated-measures analyses of variance were used in order to analyse the data. The alpha level was set at 0.05.

Results: This study found that KT had statistically significant influence on the ankle proprioception at the sagittal plane of motion ($p=0.037$). The comparison between the KT and the non-taped for the Overall Stability Index was close to be significant ($p=0.051$). Kinesiology taping indicated improvement for the mean values compared to both AT and non-taped group. There were no statistically significant results between the AT and KT.

Conclusion: The study indicates that an inexpensive modality, such as KT, can enhance ankle proprioception in healthy population and therefore reduce the occurrence of ankle injuries. Further studies are essential in order to investigate the effectiveness of taping methods on ankle proprioception in a population with ankle musculoskeletal injuries and pathology.

Keywords: Ankle; Proprioception; Kinesiology taping; Adhesive taping

Introduction

Ankle sprain is one of the most common musculoskeletal injuries, with prevalence to the lateral side (85% of all ankle sprains) [1,2]. The most common mechanism for a lateral ankle sprain is excessive inversion and plantar flexion of the talocrural joint [3], while the most common injured ligaments are the Anterior Talofibular (ATFL), the Calcaneofibular (CFL) and the Posterior Talofibular (PTFL) [4].

Adhesive or athletic taping (AT), with rigid properties, is a temporary modality adopted to act as a measure of prophylaxis providing mechanical stability and/or to accelerate post-injury rehabilitation [5]. The goal of this type of taping is to: restrict motion of injured joint; compress soft tissue surrounding the joint to prevent swelling; support anatomical structures involved in the injury and enhance re-injury prevention by amplifying proprioception and sensory feedback [6-8].

Kenzo Kase designed Kinesio Tape, an elastic adhesive tape with components that mimic the qualities of the skin [9]. There are numerous brands of Kinesiology Tape (KT). Both taping methods have

numerous techniques that are supposed to assist joint proprioception [10,11]. Proprioception is the ability of someone's own body and limb orientation, position and motion awareness [12]. Stimuli from the nervous system derive from physical stimulation of various sense organs, the mechanoreceptors, which are activated via body movements [13].

However, literature shows contradictions with regards to the taping effectiveness on the ankle proprioception [14]. Studies employing healthy participants have demonstrated controversial results on protocols designed to detect proprioceptive changes, yielding statistically significant improvements on both taping methods [15-20] as well as no proprioceptive enhancement [21-24]. Research on patients with proprioceptive deficit derived from musculoskeletal injuries (e.g. chronic ankle instability (CAI); functional ankle instability (FAI); ligament tears) and stroke episodes indicated a general statistically significant positive outcome on ankle proprioception [25-29] with controversial results [30,31] and two studies with negative results.

The first study of those which had negative results utilized AT on patients with recurrent ankle sprain, resulting in decreased ability to detect inversion-eversion movements [32]. The second one employed healthy, college age, volunteers with an AT application, indicating a

negative influence on Balance Error Scoring System (BESS) [23]. Researchers have examined KT and AT separately in different conditions, except one study by Long et al. [19] where the AT and KT are being compared in a uniaxial plane of motion. Most of the studies use non-weight bearing protocols, which abase the ecological validity of their outcomes and question their performance in a real environment. Only a small number of studies reported the effectiveness of KT methods on ankle proprioception during weight bearing protocols [17,28,29]. Most of these studies used individuals with musculoskeletal injuries or healthy controls whilst there is limited evidence that the taping works in professional athletes [24]. Even fewer studies reported that the AT methods in weight bearing protocols can improve proprioceptive acuity in healthy participants [15,33]. Inconsistencies in the methodologies of the existing protocols lead to a skepticism with regards to whether these taping techniques should be used clinically or not. Despite that, it is noted that there is an increase in popularity and usage of AT and KT application in the past years.

The aims of this study is to investigate the effectiveness of AT and KT methods on ankle proprioception in multi-axial plane of motion and compare the two methods for any pre-eminence between them. In order to isolate the ankle joint, a single leg stance was used with no visual or vestibular restrictions. Data were collected from a multi-axial platform, which allowed joint movement in all planes of motion.

Methods

Twenty healthy participants affiliated with our University (7 males and 12 females) volunteered to take part. This study was approved by the Institution's Research Ethics Committee (REC). Written consent was obtained from each participant before data collection. Leaflets and adverts were posted in the sport facilities of the University. Participants willing to volunteer contacted the author. A participant information sheet was distributed to the volunteers after the indication of interest.

Inclusion criteria

- No musculoskeletal injuries in the past 6 months participants [34].
- Age between 18-35 [35].
- Individuals who were fluent in the English language.

Exclusion criteria

- Ankle anterior drawer test positive (>4-5 mm) [36].
- Lateral Talar tilt test positive (indications of pain and/or popping or clicking) [36].
- Neurological or circulatory diseases diagnosed in the lower limb [33].
- History of any previous serious ankle injury requiring surgery or leading to reoccurring sprain and/or strain incidents.

The design of the study was a randomised intervention including three parameters: non-taped, AT and KT. The measurements were taken on one group, spanning over two non-consecutive days with a gap of at least 7 days (mean \pm SD, 10.05 \pm 5.85). Specific time gap was selected according to the indications of Jackson et al. [28]. Proprioception was assessed with balance tasks in a multi-axial plane utilising Biodex Balance System (BBS) (Biodex Medical Systems, Shirley, NT, USA). The test-retest reliability of the previous model of BBS was $r=0.094$ [Overall Stability Index (OSI)], $r=0.95$ [Anterior/Posterior Stability (APS)] and $r=0.93$ [Medial Lateral Stability (MLS)] for stability levels 1-8 (8 the most stable) in active adult population

[37]. The comparison between a collegiate group of athletes yield reliability estimates of $r=0.92$ (OSI), $r=0.89$ (APS), $r=0.93$ [Medial Lateral Index (MLI)] [37]. For the current utilised model reliability results exist only for the Overall Stability Index (OSI). It showed a good and acceptable reliability ($r=0.69$) but with a high percentage of variation of method error near to 25% [38].

Participants were tested on the "Athlete Single Leg Stability Test" of the BBS. The goal of the test was for the participants to keep the cursor in BBS's screen closer to the centre (Figure 1). If any movement was necessary, they were encouraged to perform it moving the ankle joint (foot).

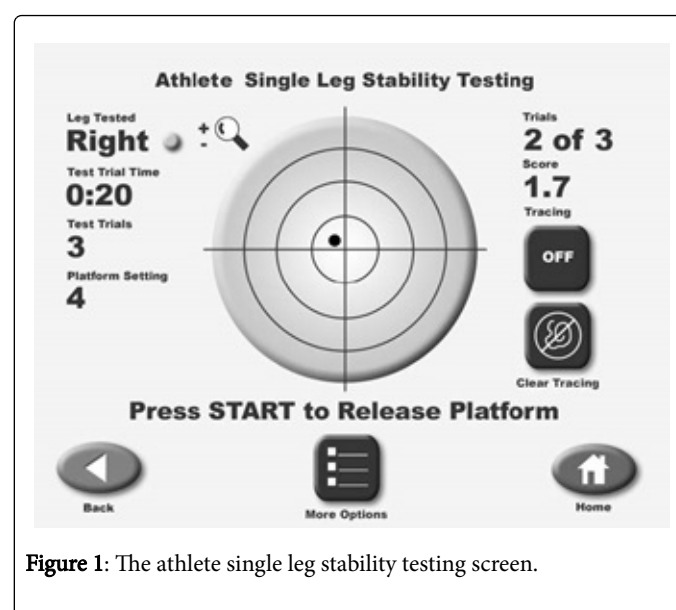


Figure 1: The athlete single leg stability testing screen.

As per system operation procedures the difficulty level was proposed to be 4/12 (12 being the most stable). However, the difficulty level was set at 8/12 because it has shown superior reliability [39] and additionally to prevent any potential injuries of trials on further unstable surface, since the participants were not exclusively athletes.

The protocol included balance trials with the three intervention testing parameters. In each parameter, participants performed three trials of 20 sec each with 10 sec break. Between each testing parameter there was a two-minute rest. The order of the parameters was randomised with the "Random number generator" (UX apps, version 1.2.7) Android application.

The purpose of the first day was to eliminate the learning effect. Participants were introduced to the BBS machine with a full-scale protocol. No measurements were recorded. Baseline data for physical characteristics were collected on the second day for each subject and included: age (based on measurement day); sex; height (Stadiometer with accuracy: 0.1 cm, Seca 213, Hamburg, Germany); weight (Scale with accuracy 0.01 kg, Seca 704, Hamburg, Germany); and leg dominance.

The posture the participants utilised was a single and barefoot leg stance of the dominant lower limb. Head and upper body were in neutral position, hands positioned on the iliac crest with the 1st digit pointing towards the anterior side and the thumb towards the posterior side. Hip and knee joints of the dominant leg were placed at 180°, while the non-dominant leg's hip joint was at 180° and with flexed knee at 90° [39]. If the participant had a 'broken posture' the

trial would be terminated and the participant would have been given only one retest trial. 'Breaking posture' is defined as when the hands are lifted from the iliac crests; touching down with the contralateral limb; moving the contralateral limb into more than 30° of hip flexion or adduction; or flexing the testing leg's knee more than 10° [40].

Taping procedures

Adhesive taping

The "Ankle anti-inversion" technique was selected and performed according to the guidance from Constantinou [41]. White adhesive tape (2.5 cm x 13.7 m) was used in combination with under-wrap (7.5 cm x 27.4 m) in order to avoid skin irritations (Tiger Tape and Tiger Wrap Underwrap, Physique Management Company Ltd, Havant, England).

Kinesiology taping

For our taping method, we used Tiger K Tape (Physique Management Company Ltd, Havant, England). Although a variety of taping techniques have been developed for the ankle, little consistency exists in the published research regarding the applicable KT techniques to the ankle. The taping technique used in this study was the "Lateral Ankle Sprain" in accordance to guidance from Dr. Kenzo Kase's book [9]. This technique was chosen because its outcome mimics the casket effect of most of AT techniques. Additionally, it targets to reinforce tendon structures and does not have additional muscle activation as a primary goal. As per manufacturers' indications there was a 20-minute pause after the application and before the measurements were initiated [9].

Both taping methods were performed by the same Sport Rehabilitator to ensure consistency throughout the study. Participants were in supine position during the taping, with their shin area off of the bed and their ankle joint dorsiflexed at 90°. None of the participants were asked to shave their skin surrounding their ankle area.

Statistical Analyses

Biodex Balance System produces three variables for each test: Overall Stability Index (OSI); Anterior/posterior Index (API); and Medial Lateral Index (MLI). Three repeated-measures analysis of variance with Bonferroni adjustments were performed, one for each dependent variable to determine any pre-eminence in-between them regarding their affect in proprioception. In order to assure that the data meet the assumption of sphericity, and therefore avoid Type I errors [42], Mauchly's test of sphericity was used. If the assumption was violated, epsilon corrections were used. At the multiple Pairwise Comparisons tests, Bonferroni correction was applied. The alpha level (α) was set at 0.05 ($p=0.05$). The data were statistically assessed with SPSS v. 24 (Chicago, Illinois, United States).

Results

Twenty participants volunteered for this study (13 females, 7 males), their anthropometric measurement results were (mean \pm SD): 25.4(\pm 3.85) years old; 168.8(\pm 12.06) cm; 72.0(\pm 12.20); 18 were right-leg dominant and two were left-leg dominant.

A descriptive statistics analysis of the three variables' data (OSI, API and MLI) in the three intervention parameters (non-taped, KT and AT) was conducted (Table 1).

	Mean	Std. Deviation	Std. Error	Dev.
Non-Taped OSI	1.2	0.49	0.11	
AT OSI	1.3	0.99	0.22	
KT OSI	0.97	0.45	0.1	
Non-Taped API	0.87	0.42	0.09	
AT API	0.96	0.91	0.2	
KT API	0.65	0.18	0.04	
Non-Taped MLI	0.72	0.3	0.07	
AT MLI	0.74	0.4	0.09	
KT MLI	0.65	0.46	0.1	
AT=Adhesive Taping, KT=Kinesiology Taping, OSI=Overall Stability Index, API=Anterior/posterior Index, MLI=Medial Lateral Index				

Table 1: Descriptive statistics results.

Mauchly's tests indicated that for the OSI and the API variables the assumption of sphericity had been violated [$\chi^2(2)=6.16$, $p=0.046$ and $\chi^2(2)=23.78$, $p<0.001$ respectively]. Therefore, epsilon corrections were used. For the OSI variable the Huynh-Feldt test was used (Greenhouse-Geisser value >0.75), whereas for the API variable the Greenhouse-Geisser test (value=0.58) was used. The MLI variable met the assumption of sphericity [$\chi^2(2)=1.6$, $p=0.45$].

The Tests of Within-Subjects Effects yield that the F ratio was marginally statistically significant only for the OSI variable [$F(1.7,31.6)=3.53$, $p=0.049$](Table 2).

		df	F	p.	Partial Eta Squared	Observed Power
OSI	Huynh-Feldt test correction	1.66 Error(OVI) 31.59	3.532*	0.049*	0.16	0.57
API	Greenhouse-Geisser test correction	1.15 Error(API) 21.93	2.547	0.12	0.12	0.35
MLI	Sphericity Assumed	2 Error(MLI) 38	0.77	0.47	0.04	0.17
OSI=Overall Stability Index, API=Anterior/posterior Index, MLI=Medial Lateral Index.						

Table 2: Tests of within-subjects effects results.

Additionally, the corresponding Pairwise Comparisons Tests did not indicate a statistical significance results, with the comparison between the non-taped and KT parameters was close to being statistically significant ($p=0.051$) (Table 3).

Although the Tests of Within-Subjects Effects for the API and MLI variables were not statistically significant, the comparison between the non-taped and KT parameters at the API variable were statistically significant ($p=0.037$). This indicates that KT affects ankle proprioception at the sagittal plane of motion.

(I)	(J)	Mean Difference	Std. Error	P value ^a	95% Confidence Interval Difference ^a for	
OSI	OSI	(I-J)			Lower Bound	Upper Bound
1	2	-0,105	0,142	1,000	-0,479	-0,479
1	3	0,235	0,090	0,051	-0,001	-0,001
2	3	0,340	0,152	0,113	-0,059	0,739
API	API					
1	2	-0,090	0,136	1,000	-0,446	0,266
1	3	0,225*	0,081	0,037*	0,011	0,439
2	3	0,315	0,192	0,354	-0,190	0,820
MLI	MLI					
1	2	-0,020	0,066	1,000	-0,194	0,154
1	3	0,070	0,086	1,000	-0,155	0,295
2	3	0,090	0,075	0,741	-0,108	0,288

1: Non-taped, 2: AT, 3: KT, API=Anterior/posterior Index, MLI=Medial Lateral Index, OSI= Overall Stability Index
^a: Adjustment for multiple comparisons: Bonferroni
*: The mean difference is significant at the .05 level

Table 3: Pairwise comparisons tests.

Discussion

The aim of this study was to investigate the effectiveness of KT and AT techniques in ankle proprioception at a multiaxial plane of movement in full weight-bearing stance and compare their values for any potential pre-eminence between them. The primary findings of this study were a reduction of the mean values, during the KT application compared to both AT and non-taped parameters, with an exception of the last two at the MLI variable (inversion/eversion movements) (Table 1). This reduction is supported by the Pairwise Comparisons tests for the API variable (Table 3) resulting with a statistically significant value between non-taped and KT parameters ($p=0.037$) and a marginally non-statistically significant value for the OSI variable between the same parameters ($p=0.051$). Lower value of the three indices have been correlated with better balance skills [43] and in extension with proprioception and neuromuscular response [37]. Thus, this tendency is an indication of improvement of the ankle joint's proprioception during KT application in an ankle multi axial

plane of movement, at healthy participants utilising a full weight-bearing stance. In addition, the KT technique presented better mean values compared to the AT technique's with no statistically significant difference between them in any of the variables.

Despite the fact that F-ratio was not statistically significant at the API variable does not mean that the Pairwise Comparisons tests' results should be discarded or that they are not of any clinical importance. According to Field [44], the application of the p. value rule can mislead us and advise researchers to expand their interpretation based on the effect size. Additionally, in accordance to Pallant's [45] Partial-Eta squared (η^2) classification, the Within-Subjects Effects results for the API variable present a 'medium' effect size ($\eta^2=0.12$). Glass et al. [46] stated that even the smallest effect size should be interpreted according to its relative costs and benefits and practical importance. Contrariwise, OSI variable indicated a statistically significant F-ratio with a 'large' size ($\eta^2=0.16$), and as aforementioned, at the Within-Subjects Effects results for the OSI variable there is a marginally non-statistically significant value between non-taped and KT parameters, a result that is most likely affected by the small sample size of the present study [47]. Since Kinesiology taping being an inexpensive modality, with indications of a 'medium' effect size on ankle proprioception at the sagittal plane (plantar/dorsi flexion-API) and marginally non-statistically significant but with 'large' effect size at the Overall Stability (OSI), it is a tool that a clinician could utilise to facilitate improvement on ankle proprioception in healthy individuals (e.g. in a proprioceptive training program).

Long et al. [19] investigated differences between the AT and KT on ankle proprioception, indicated that there was no statistically significant difference between the AT and KT methods on ankle proprioception in a full weight-bearing stance utilising an Active Movement Extent Discrimination Apparatus (AMEDA) in the coronal plane of ankle movement (inversion/eversion). The results between the AT and KT methods of this study in the coronal plane of movement (MLI), agree with Long et al.'s results. Furthermore, based on their non-taped results Long et al. divided the participants into two groups: above the average and below the average. Results after the division indicated that in an uniaxial plane of movement (inversion/eversion) taping (AT and KT) around the foot and ankle may amplify sensory input in a way that enhances proprioceptive performance of poor performers (below the average group) but overloads input and impairs proprioception of those who originally performed well when not taped (above the average group) [19]. The type of taping did not indicate a statistically significant difference [19]. In the present study there was no further division, as in Long et al.'s study, even though the three parameters were randomly assigned to each individual in both studies. Randomising the sequence of the parameters alters the non-taped group results and therefore the baseline for the division that would have defined the conclusion of this study.

Highly proprioceptive acuity is positively connected with minimising injury (re)occurrence [48]. Improper post injury rehabilitation increases the chances for injury re-occurrence [48]. Consequently, it can be concluded that injury (re)occurrence is inversely proportional with proprioceptive acuity and rehabilitation. Based on the indications of this study, KT can be utilised in order to enhance the proprioception and minimize the risk of any injury occurrence. Additionally, there are indications that AT is more valuable in the rehabilitation phase [49], thus explaining the non-

statistically significant results in a healthy population as well as those of the present study.

Limitations

This study used moderate to no active participants. Further research is needed to investigate if the indications of this study could be applied on semi-professional, professional individuals or individuals with ankle conditions such as Chronic Ankle Instability (CAI), Functional Ankle instability (FAI) and/or further musculoskeletal injuries. The limited amount of participants resulted to marginal statistically significances of this study. Studies with larger participant numbers need to be conducted in the future in order to create a cohesive clinical guidance.

Conclusion

This study concluded that an inexpensive modality, like kinesiology taping can eventually improve proprioception and minimise injury occurrence in healthy individuals. Clinicians could employ such techniques in their everyday practise.

Future studies should address participants who have ankle musculoskeletal injuries and pathology in order to observe if clinicians utilising taping methods could expedite rehabilitation through an improvement on proprioception and ergo the return to play time.

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Conflict of Interest

None declared

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